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AD

AD843597

TECHNICAL MANUSCRIPT 468

STEM RUST INFECTION AND DEVELOPMENT IN ARTIFICIALLY INOCULATED FIELDS OF WHEAT AT HAYS, KANSAS, AND ITS EFFECT ON YIELD, 1960 TO 1965

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AUGUST 1968

DEPARTMENT OF THE ARMY
Fort Detrick
Frederick, Maryland

10

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Project 1B522301A061

August 1968

STEM RUST INFECTION AND DEVELOPMENT IN ARTIFICIALLY INOCULATED FIELDS OF WHEAT AT HAYS, KANSAS, AND ITS EFFECT ON YIELD, 1960 TO 1965

ABSTRACT

Most wheat varieties growing in the vicinity of Hays, Kansas, are susceptible to races of *Puccinia graminis* f. sp. *tritici* that are common in central United States. However, they are seldom severely damaged by stem rust. It is commonly thought that weather in that area is not favorable for establishment and development of stem rust. In 1960 to 1965 the epidemiology of stem rust was studied at Hays in fields of Cheyenne wheat inoculated with urediospores of race 56 when the plants were in tillering to boot stages of growth. Infection occurred in all 6 years. Rust increase was related to the frequency of days when conditions were favorable for infection. Plots with initial intensities of 2.5 to 20 pustules per 100 culms were compared. In the 6 consecutive years (1960 to 1965) severities at soft dough stage were about 30, 25, 7, 2, 2, and 20%; yields for rusted plots were 20, 19, 25, 34, 22, and 18 bu/acre; and yields for adjacent control areas were 46, 29, 45, 35, 29, and 62 bu/acre, respectively. In 1965, a natural epidemic of stem rust caused severe damage to wheat in Kansas and Nebraska. In 1965, the crop ripened late in the season. In 5 of the 6 years, weather was favorable for rust epidemics. Late natural infection appeared to be the primary factor limiting severity of the rust epidemics.

Most of the varieties of wheat that are grown in the vicinity of Hays, Kansas, are susceptible to the races of *Puccinia graminis* Pers. f. sp. *tritici* Eriks. and E. Henn. that commonly occur in central United States. However, the wheat crop in that area is seldom severely damaged by stem rust. The commonly accepted explanation for the limited damage caused by stem rust is that the weather in that area is not favorable for the development of stem rust.

In six consecutive years, 1960 to 1965, we studied the infection, development, and destructiveness of stem rust at Hays, Kansas. Hays has a mean annual rainfall of 22.7 inches. Because of the relatively dry weather, farmers usually rotate wheat with a year of summer fallow to conserve moisture. In each of the 6 years, four or five plots of Cheyenne wheat, 0.5 to 1 acre in size, were inoculated with urediospores of race 56

relatively early in the season when the plants were in the tillering to boot stages of growth. In most years an uninoculated plot was also included in the study to provide information on the naturally occurring rust in each area. Each plot was inoculated with a different amount of rust to obtain a range of initial rust intensities.

Figures 1 to 6 show a representative example of rust development and yield in each of the years from 1960 to 1965. The examples selected had similar initial levels of rust intensity. In the examples, initial intensities ranged from 2.5 to 20 pustules per 100 culms.

Figure 1 shows the increase of stem rust in 1960 and the yield of wheat from a rusted plot and adjacent areas that were sprayed with fungicides to control rust. Rust intensities are shown on a logarithmic scale. Early intensities are expressed as pustules per culm. Late intensities are expressed as percentage severity of infection according to the modified Cobb scale. Ten pustules per culm were equivalent to 1% severity. Therefore, rust development is plotted on a continuous scale. The dots at the top of the figure show the days when conditions were favorable for infection. Days with 6 or more hours of continuous moisture at 10 C or higher were considered favorable days for infection. In 1960, conditions were favorable for infection throughout most of the season, rust increased rapidly, and yield was reduced from 46 bushels per acre in the control area to 20 bushels per acre in the rusted area.

In 1961 (Fig. 2), conditions were also favorable for rapid rust development and yield was reduced from 29 to 19 bushels per acre.

In 1962 (Fig. 3), favorable conditions for infection were frequent, rust increased to 7% severity by the soft dough stage, and yield was reduced from 45 bushels per acre in the control area to 25 bushels per acre in the diseased plot.

In 1963 (Fig. 4), the plants were inoculated at a later stage of plant growth. In 1960, 1961, and 1962, the plants were in the jointing stage when inoculated. In 1963 they were in the boot stage. The weather was not favorable for infection until 14 and 15 days after inoculation. Consequently, rust increase was delayed. Rust increased to 2% severity by the soft dough stage. Because of the late inoculation and the delay before favorable weather, no significant damage occurred.

In 1964 (Fig. 5), the plants were inoculated when in the tillering stage of growth. Favorable conditions for rust infection occurred 8 and 9 days after inoculation, but at that time pustules were just beginning to appear. Consequently, only a slight increase in rust intensity occurred from 20 to 23 days after inoculation. A second increase in rust intensity (27 to 36 days after inoculation) was associated with favorable conditions for infection on the 18th day after inoculation. The two decreases in rust

intensity were associated with the absence of favorable days before and after the 18th day. No new pustules developed during those periods and the number of old pustules was reduced because of the loss of leaves. The great loss of leaves was primarily because of drought conditions that prevailed at that time. Finally, near the end of the season, conditions were favorable for rapid rust development. However, at that time the plants were suffering from the effects of the drought and as a result they ripened earlier than normal. Rust developed to 10% severity by the end of the season. Damage was less than in 1960, 1961, and 1962, but still relatively severe.

In 1965 (Fig. 6), favorable conditions for infection were frequent from 13 May to the end of the growing season. Rust increased to 20% severity by the soft dough stage and 70% severity by the end of the season. The crop was later than normal; consequently, more time was available for the rust to increase. Severe damage occurred. Yield was reduced from 62 bushels per acre in the control area to 18 bushels per acre in the rusted area.

In this same year, 1965, a natural epidemic of stem rust severely damaged wheat in much of Kansas and Nebraska. The late crop and favorable weather for rust development were important factors contributing to the epidemic.

In conclusion, at Hays, Kansas, rust was established in field plots in 6 consecutive years and severe damage from stem rust occurred in 5 of the 6 years. In one of the years, severe damage from a natural epidemic also occurred in the same general area. From these 6 years of study it is apparent that the requirement commonly lacking for epidemic development of stem rust is the absence of viable rust inoculum early in the growing season. Temperatures and moisture occurrence patterns are acceptable, as illustrated by the fact that rust development and damage does occur when inoculum is supplied early and in sufficient amount.

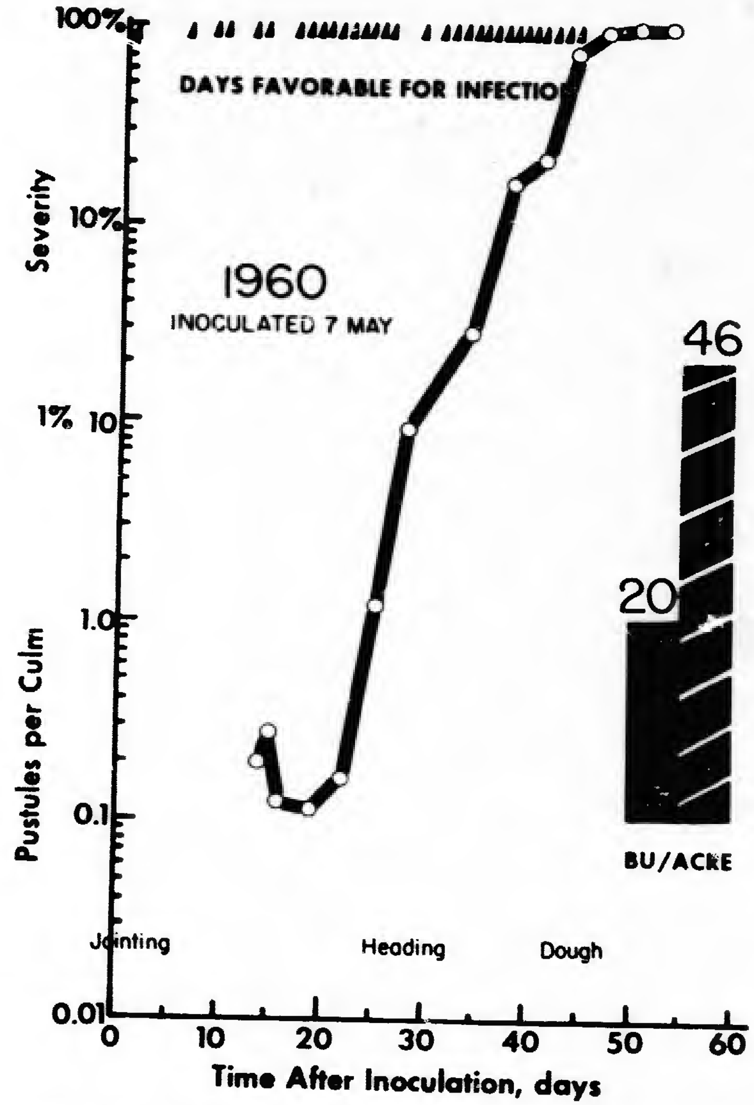

Figure 1. Stem Rust Development in Inocul‑ted Plot in 1960. Inoculated on 7 May.

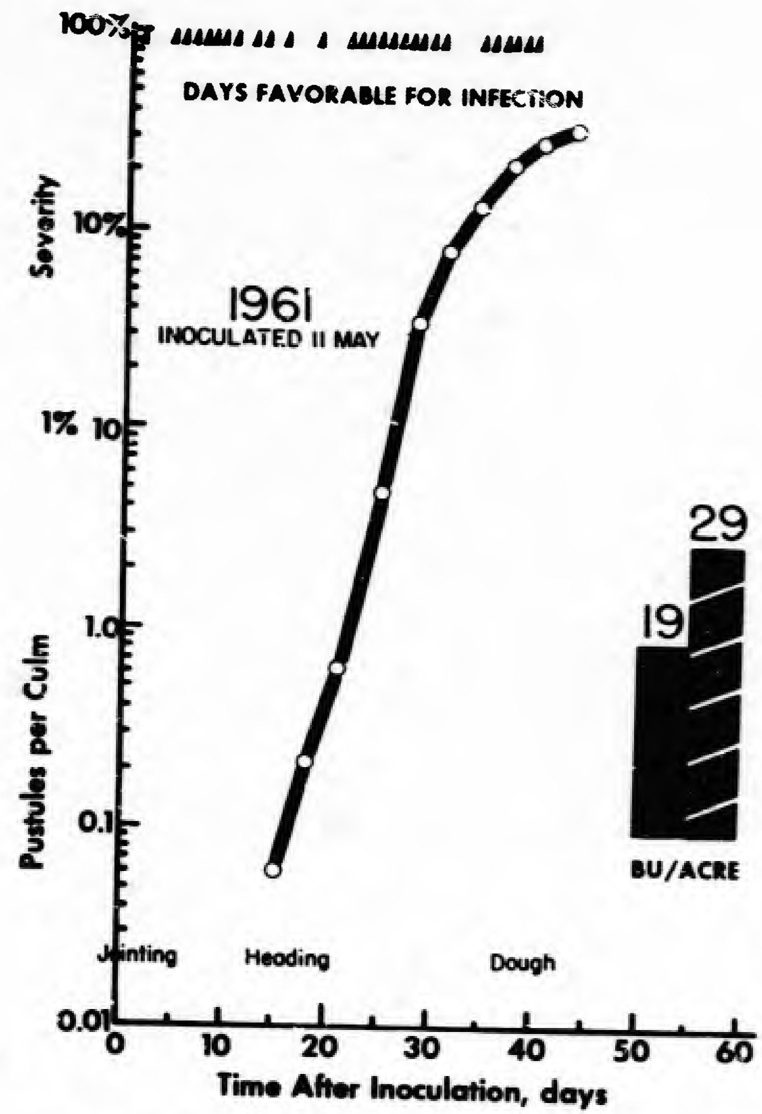

Figure 2. Stem Rust Development in Inoculated Plot in 1961. Inoculated on 11 May.

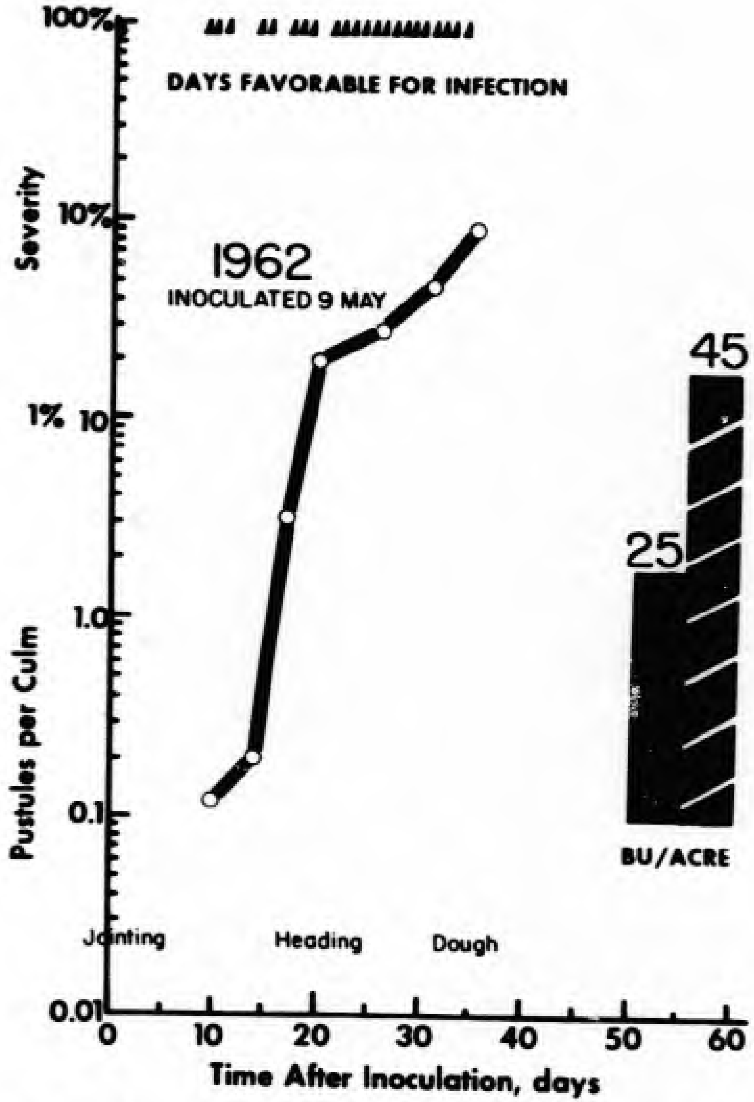

Figure 3. Stem Rust Development in Inoculated Plot in 1962. Inoculated on 9 May.

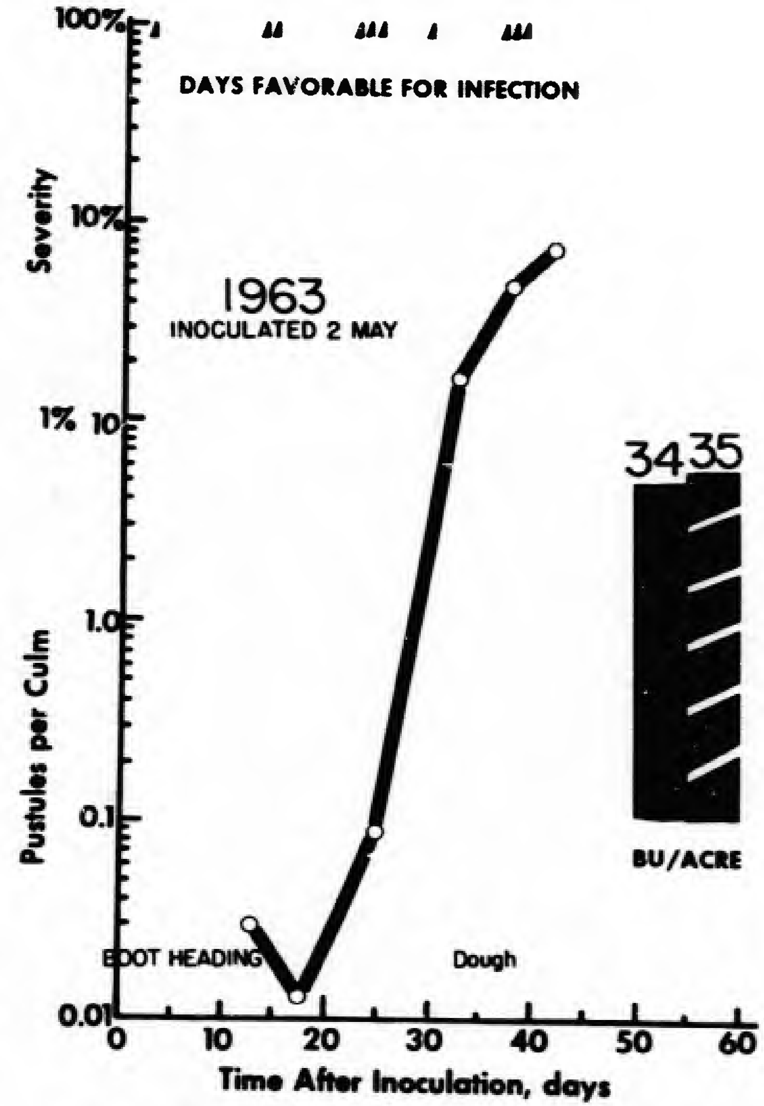

Figure 4. Stem Rust Development in Inoculated Plot in 1963. Inoculated on 2 May.

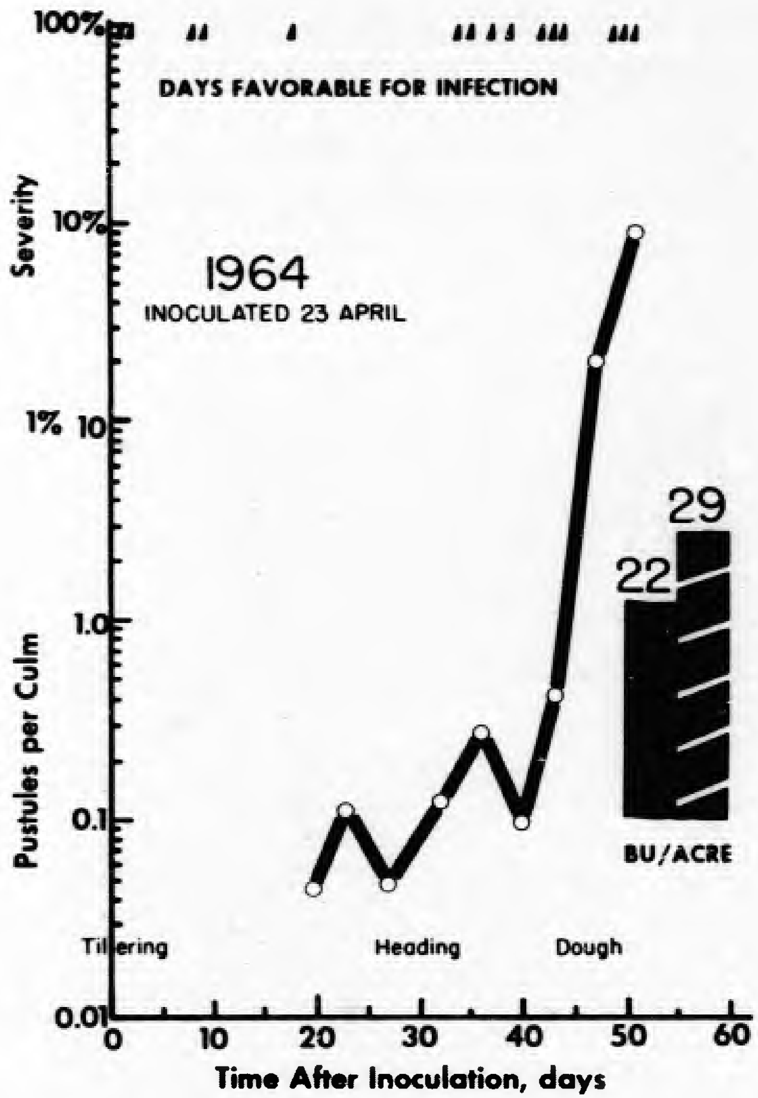

Figure 5. Stem Rust Development in Inoculated Plot in 1964. Inoculated on 23 April.

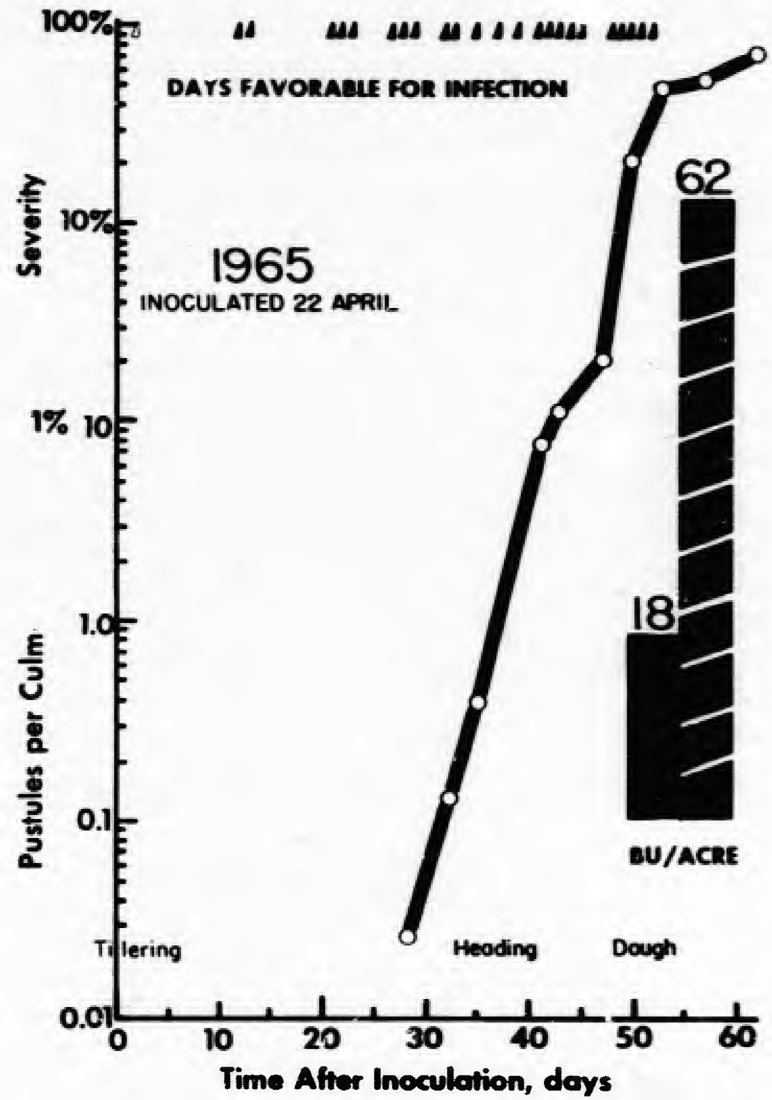

Figure 6. Stem Rust Development in Inoculated Plot in 1965. Inoculated on 22 April.

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author)
Department of the Army
Fort Detrick, Frederick, Maryland 21701

2a. REPORT SECURITY CLASSIFICATION
Unclassified

2b. GROUP

3. REPORT TITLE
STEM RUST INFECTION AND DEVELOPMENT IN ARTIFICIALLY INOCULATED FIELDS OF WHEAT AT HAYS, KANSAS, AND ITS EFFECT ON YIELD, 1960 TO 1965

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

5. AUTHOR(S) (First name, middle initial, last name)
Roland F. Line
Clyde E. Peet
Charles H. Kingsolver

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
August 1968	11	none

8a. CONTRACT OR GRANT NO.

b. PROJECT NO. Project 1B522301A061

c.

d.

9a. ORIGINATOR'S REPORT NUMBER(S)
Technical Manuscript 468

9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)

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11. SUPPLEMENTARY NOTES

12. SPONSORING MILITARY ACTIVITY
Department of the Army
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14. Key Words

*Stem rust
*Puccinia graminis tritici
*Wheat
*Climate
Kansas
Epidemiology